## Social Behavior of *Geochelone denticulata*

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Several lines of evidence suggest that in nature Galápagos tortoises (*Geochelone elephantopus*) make seasonal vertical migrations between coastal and mountain pastures, in herds, along deeply worn narrow trails only wide enough for one animal to pass. Townsend (1925) states that each member of a migrating group remains in its respective place in line, suggesting the establishment of at least a temporary hierarchal social behavior.

In 1951 Evans and Quaranta reported on their studies of the types and level of sociality in a captive herd of Galápagos tortoises. They concluded that a type of social pattern was evident in their experimental animals. Large specimens tended to be more sociable and of a higher social rank than smaller ones. Males tended to be more sociable than females. Females were rather asocial to one another but more social to males. Whether this type of social pattern is found in wild tortoises remains unknown. Futhermore, it is not clear how sociability (the endogenous urge on the part of one individual to be near another) relates to social rank in these tortoises.

The present study attempted to determine whether the same, or a similar social pattern exists in a closely related species, *Geochelone denticulata*, a species with low population densities and inhabiting mesic tropical forests or thick brush (Medem, 1960; Pritchard, 1964) in the Amazonian basin. Individuals are undoubtedly wide ranging and completely nomadic. Contact between individuals is undoubtedly not common in nature. For these reasons hierarchal social patterns of the type demonstrated to be present in *G. elephantopus* were presumed to be absent in *G. denticulata*.

### Procedure and Description

Observations were based on six adult specimens of *Geochelone denticulata*, obtained by Peter Pritchard in Surinam during the summer of 1967. Since their arrival in Gainesville, Florida, they have been kept in a large outdoor pen, located in a mature beech-magnolia forest. Most food was provided, in the form of mammal

and avian carrion, table scraps and garden produce; native vegetation, such as flower blossoms and certain forbs, was also eaten. Water was originally provided by rainfall accumulation in an excavated depression. A small portion of a pond was included within the fenced area in the spring of 1968, when the pen was enlarged. The large size of the pen and its location allowed the tortoises considerable choice in regard to microhabitat, particularly in the larger 1968 pen. Within the enclosed area conditions ranged from open, grassy pond edge, through closed canopy mature forest with little understory vegetation, to dense brush and vine thickets under the canopy (Fig. 1). The tortoises spent most of their time in the wet, dense portion of the pen (Table 1).

TABLE 1
Habitat selection (per cent of total observations)

| Open forest Area A | Shaded forest Area B | Hydric forest Area C | Grass Area D |
|---|---|---|---|
| 2 | 9 | 89 | 0 |

The tortoises in the Evans and Quaranta study were unfortunately locked in a small houselike shelter each night, tortoises failing to enter the shelter being urged inside by the keeper. This was not necessary in the present study, and the tortoises selected their own evening shelter. Food was not provided in the same place every day as in Evans and Quaranta's study, but scattered over the pen to simulate natural conditions. Native Florida forests do not provide sufficient blossoms and fruits to sustain these tortoises without supplement.

*Geochelone denticulata* inhabits dense tropical evergreen forests and does not sun itself in captivity. Thus, the positions of both feeding and sunning tortoises, utilized in the Evans and Quaranta study, were not recorded here. Neither were the morning resting patterns tabulated, since they are obviously slightly modified evening resting patterns. In this study the degree of sociability was established by recording the positions assumed by each of the tortoises in their evening sleeping positions with reference to other individuals and certain landmarks within the pen. In addition,

the positions of crawling tortoises were plotted whenever possible to establish an estimate of individual movement.

All the tortoises remained alive until March 6, 1968, when tortoise number 1 was found dead in the shelter used during the colder periods of the winter. Each of the tortoises was marked with a large, yellow numeral painted on the shell (1 to 6). All were adult, and the group included two males and four females (Table 2).

TABLE 2

Size and sex characteristics of experimental animals

| Number | Sex | Carapace length (in mm) |
|---|---|---|
| 1 | F | 345 |
| 2 | M | 305 |
| 3 | F | 456 |
| 4 | F | 403 |
| 5 | F | 386 |
| 6 | M | 332 |

For 43 consecutive days during the late summer and fall of 1967 observations were made in the smaller pen, which included two shelter areas. The most commonly used shelter was next to the rotting trunk of a 12 inch diameter fallen tree. The area on either side of the trunk could accommodate all of the tortoises (Fig. 1, log). The other shelter area could receive only one tortoise. It was a small, low tangle of a few grape vines (Fig. 1, vines). Certain tortoises did not use an evening shelter, but always spent the night in a pallet, i.e. an area scraped relatively free of fallen leaves and twigs. Two areas where there was a natural accumulation of many fallen tree leaves were most often the site of pallet construction (Fig. 1, P). These forms, or pallets, have been described for several species of *Gopherus* in North America (Auffenberg and Weaver, 1969) and for *Geochelone carbonaria* in the forests of Panama and *Geochelone chiliensis* in the Chaco of Argentina (Auffenberg, unpublished).

Each of the six turtles moved freely about the pen and changed their resting stations an almost equal number of times (Table 3).

TABLE 3
Evening resting station changes per tortoise (autumn, 1967)

| Tortoise No. | Station changes |
|---|---|
| 1 | 36 |
| 2 | 30 |
| 3 | 32 |
| 4 | 32 |
| 5 | 34 |
| 6 | 33 |

Therefore, none of the tortoises were significantly more active than any of the others.

Of 258 maximum possible resting stations (6 tortoises x 43 days), 202 were next to the fallen log, while only 56 occurred throughout the rest of the pen. Of these, 31 were at the vine clump. This nonrandom distribution was due to either shelter availability, a strong level of sociability in the tortoises, or a combination of these. Individual sociability level and type was determined by recording the resting stations of the tortoises with respect to one another during this period. The shells of the tortoises often touched one another while the tortoises were in their resting stations. Contact was made between some turtles more often than others (Table 4). Tortoises 1 and 3 rarely failed to contact another tortoise while sleeping; most often this contact was with one another. Tortoises 2, 4, 5 and 6 often spent the evening without contacting another tortoise. No other pattern was recognizably significant.

With the onset of cold weather in winter, brush and leaves were piled over the log (Figs. 1, 2). It was in this brush pile that the tortoises stayed during the colder days and nights, though some ventured out for a few hours in the middle of the day during particularly warm days. The resting patterns of the tortoises were not tabulated until spring. From March 9 through April 19 the

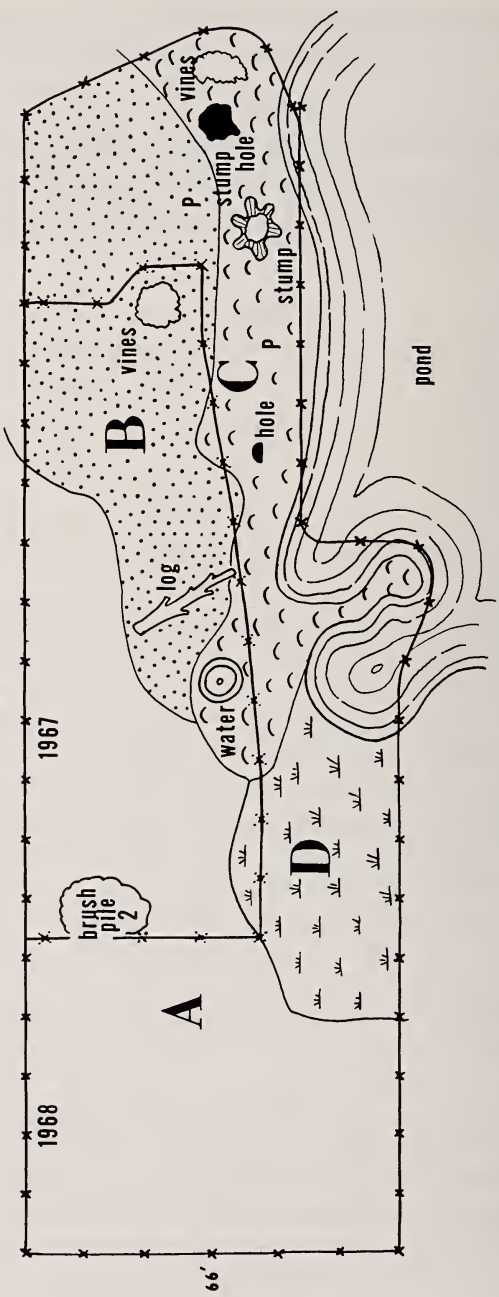


Fig. 1. Pens in which *Geochelone denticulata* were studied in 1967-68, located near Gainesville, Florida. A, Dry, open magnolia beech association. B, Mesic, shaded magnolia-beech association. C, Hydric, sweetgum-bay association. D, Open, grassy area.

resting positions of the remaining 5 tortoises (No. 1 had died) were recorded for 42 days. The results were not significantly different from those of the fall, except that the number of intertortoise contacts were slightly less. This was presumed to be due to the larger shelter area provided by the brush pile when compared to

Fig. 2. Interior of pen viewed from brush pile 2, showing brush pile 1 built over fallen log.

TABLE 4
Intertortoise contacts during sleep (autumn, 1967)

| Tortoise No. | No contact | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1 | 5 | | | | | | |
| 2 | 13 | 8 | | | | | |
| 3 | 8 | 17 | 0 | | | | |
| 4 | 12 | 3 | 2 | 1 | | | |
| 5 | 15 | 1 | 3 | 4 | 8 | | |
| 6 | 16 | 2 | 4 | 2 | 6 | 3 | |

the log. This suggested that the nonrandom distribution of resting tortoises was not entirely the reflection of a high level of sociability.

To test the effect of a lower population density and additional shelters on level of sociability the area of the original pen was increased by approximately 200 per cent (Fig. 1). Of this total new area the tortoises normally utilized only 50 per cent, the more mesic portion. Several additional shelters were deliberately included in the new enclosure—a large stump overgrown with vines, an abandoned armadillo hole, another low mass of vines, and a large overgrown stump hole. In addition, another brush pile was constructed in the open, more xeric part of the forest. Observations were made every evening from May 10 to June 30. With the additional space and shelters the grouping tendency of the remaining five individuals disappeared completely (Table 5). The infer-quency of sleeping contacts is believed due to the fact that there was a decided tendency for each tortoise to repeatedly use a specific and individual evening shelter. Groupings only occurred at the largest shelters. There was no evidence that aggressive behavior played any role in shelter use or resting position.

The most significant conclusion is that when population density is not abnormally high and when sufficient shelter is available there is no social pattern in *Geochelone denticulata* as has been reported in *G. elephantopus*. The level of sociability in *G. denticulata* is simply a function of shelter utilization, plus population density (Table 6). The behavior of the individuals of *G. denticulata* studied is believed to be much closer to that typical in nature than

TABLE 5

Intertortoise contacts during sleep (spring, 1968)

| Tortoise No. | No contact | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 2 | 48 | | | | | |
| 3 | 23 | 0 | | | | |
| 4 | 38 | 0 | 11 | | | |
| 5 | 39 | 3 | 10 | 0 | | |
| 6 | 41 | 1 | 8 | 2 | 0 | |

TABLE 6

Percentage comparison of intertortoise contacts during sleep in high (in parentheses) and low (no parentheses) population densities

| Tortoise No. | No Contact | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1 | 100 | | | | | | |
| 2 | 100(61) | 39 | | | | | |
| 3 | 100(32) | 68 | | | | | |
| 4 | 77(67) | 16 | 11 | 17(23) | | | |
| 5 | 75(48) | 3 | 9(6) | 12(19) | 28 | | |
| 6 | 79(49) | 6 | 12(2) | 6(15) | 18(4) | 9 | |

the behavior of *G. elephantopus* reported by Evans and Quaranta. Sociability of the type and level described by Evans and Quaranta in their captive herd of *G. elephantopus* were obtained in the present study of semi-wild *G. denticulata* only when shelter was limited. It is my belief that the conclusions of Evans and Quaranta will not be borne out in nature where individuals are scattered and pallets can be excavated in many brush clumps. However, social behavioral patterns may have importance during dry periods when Galápagos tortoises are concentrated around water holes, or during group migrations in those few populations that seem to do so.

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